AMERICAN

RAILROAD JOURNAL.

STEAM NAVIGATION, COMMERCE, FINANCE,

INSURANCE, BANKING, MINING, MANUFACTURES.

HENRY V. POOR, *Editor.*

SATURDAY, JULY 2, 1859.

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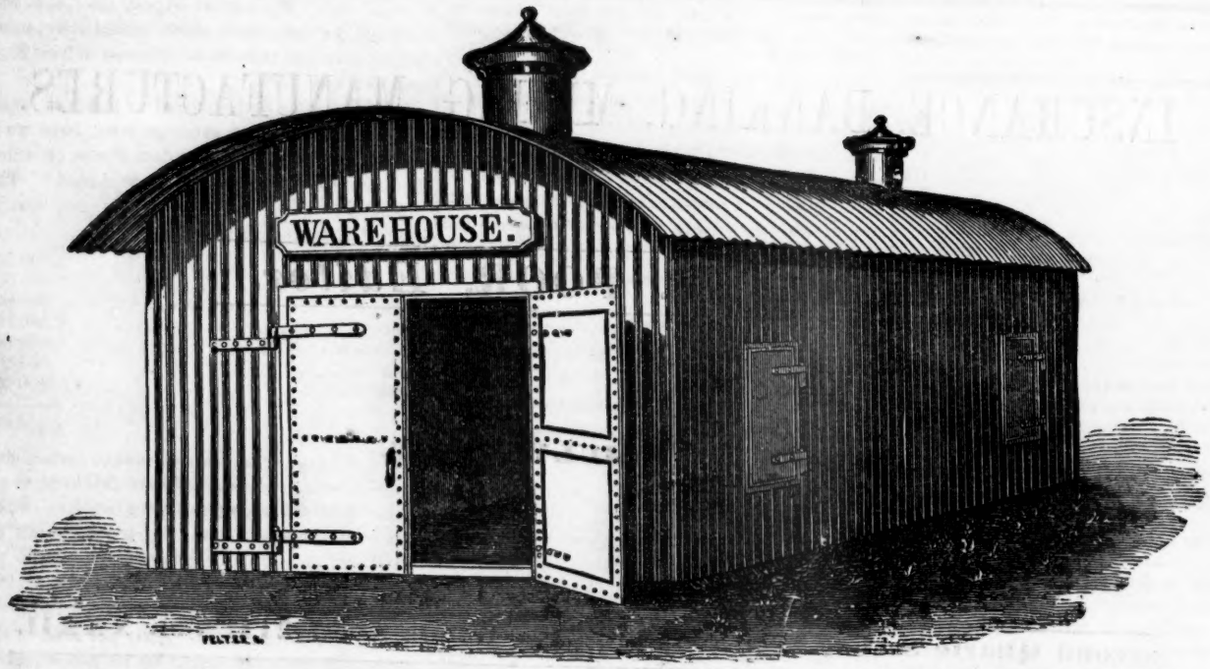

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PRINCIPAL CONTENTS.

American Railroad Journal.

PUBLISHED BY J. H. SCHULTZ & CO. No. 9 SPRUCE ST.

New York, Saturday, July 2, 1859.

Parkville and Grand River Railroad.

This is a proposed railroad to connect the Missouri River, near the western boundary of the State, in Platte County, with the Hannibal and St. Joseph Railroad. The distance is from 45 to to 50 miles. The route has been located, and a section of five miles placed under contract. It is proposed to raise the means for its construction in a rather novel, but very proper manner—to assess its cost upon the real and personal property lying within five miles of its line. For this purpose authority has been obtained from the legislature to submit the question to a vote of the parties proposed to be taxed. Should a favorable result be obtained, the road can be built without issuing bonds. The route is an easy one. The whole cost being estimated at $750,000. A sufficient sum has already been subscribed to grade the road. The report of the directors speak in an encouraging manner of its probable success. The present board consists of L. C. Prunty, Robert Cain, Wm. K. Faulconer, Geo. S. Park, Levi Hinkle, C. P. Summers, Alfred Gray, J. W. Wright, F. Johnson, of which Geo. S. Park is President. The office of the company is at Parkville, Mo.

How much can our people pay annually for the Transportation of Persons and Property?

In the construction of a railroad, or of a system of railroad, a lucrative business is assumed as a matter of course. Our people never stop to consider whether there must not be a limit to the ability of a people to contribute to the support of such works—a necessary relation between their number and the extent of their commerce—and whether all beyond a certain outlay for works of improvement must not remain without adequate employment.

What is the extent of the contributions that a community can make toward the support of railroads? The people of Massachusetts pay more, to these works than any other community in the world. The receipts of her roads compared with her population for 9 years past have been as follows:—

	Earnings.	Population.
1850	$7,089,159	973,654
1851	7,281,346	1,005,397
1852	7,713,208	1,037,140
1853	8,966,441	1,068,883
1854	9,973,377	1,100,626
1855	10,100,914	1,132,369
1856	10,884,667	1,164,112
1857	10,583,574	1,195,855
1858	9,522,968	1,227,598

The above statement shows the ratio of earnings of railroads in Massachusetts to be very nearly nine dollars to each person.

In England and Wales, the largest earnings for any one year, 1858, were $97,862,781, for a population of about $19,100,000, giving a ratio of $5.12.5 to each person.

The earnings of the railroads of New York, for 1856 were $21,289,340: Population for the same year, 3,550,000: Ratio of earnings to population, $6.

New England has a railroad system peculiar to itself. Only a very small portion of its receipts is contributed by the people of other States. The earnings of its roads for 1856 were $18,657,273: its population very nearly 3,100,000: ratio of earnings to population the same as in New York, $6 per head.

There is, of course, a constantly increasing ratio between the earnings of railroads and the population contributing to their support, but not a rapid one. We cannot expect then that any State or section should show, immediately, more favorable results than those obtained in New England and New York.

If we take the States named as the most favorable instances of large earnings, what have we a right to expect from the Western States in which this interest is now greatly depressed? The population of these States is now very nearly 7,400,000, made up as follows:—

Ohio	2,300,000
Indiana	1,200,000
Michigan	800,000
Illinois	1,500,000
Wisconsin	800,000
Iowa	600,000
Minnesota	200,000
	7,400,000

The earnings of all the railroads of these States for 1858, were very nearly $33,000,000 or $4.46 per head. Five dollars per head, we conceive, would be a large average. It will be several years before it will go as high as $6 per head. At $5 per head the gross earnings would be $37,000,000. This ratio, with good crops, will probably be reached the coming year. Sixty per cent. of this sum which certainly ought to be *net*, would be $14,800,000. The total cost of the roads of these States amounts to $250,000,000.

Such a result in gross would show net earnings equal to six per cent. upon the whole investment. The railroads of Massachusetts have earned in the aggregate just about six per cent. on their cost from the date of the construction of the first road. But the earnings of the roads, as in the west, are so unequally distributed, that a large amount of capital invested remains unproductive.

The experience of the railroads running into Chicago shows that their receipts cannot be expected to increase in the same ratio as their mileage. Every new road constructed reduces just so much the productiveness of capital already invested, either by dividing the business, or by turning trade in new directions. Ohio, Indiana and Illinois are already overstocked with these works. It would be well if those of the newer States could proceed at a slower and more uniform rate than has characterized their progress in the States named. Only so much money

can be got out of a given area, or a given population. The amount to be invested should have direct reference to those two elements. The instant the true ratio is exceeded, loss must ensue. We have had too much experience to throw away the lesson it has taught us.

It is now pretty easy to determine what a proposed road will be likely to earn. Not to adapt the expenditure to such probable earnings, is to wilfully throw away the experience we have gained.

Mississippi Central Railroad.

PRESIDENT'S REPORT.

During the fiscal year ending April 30, contracts were entered into for all the graduation, and bridging, on the line of the road not previously under contract. Sixty-five hundred tons of iron rails were purchased of Geo. Peabody & Co., of London, in September last, to be delivered in New Orleans. This is deemed sufficient to complete the main track of the road. Three thousand tons have been received; the residue may soon be expected.

All the necessary fastenings for laying down the iron have been purchased, a large part of them received, and the remainder will be delivered as required for the prosecution of the work.

The non-compliance of many of those who had entered into contracts for the delivery of cross-ties, with the terms of their agreement, has been a fruitful source of delay and disappointment in the progress of track-laying. To avoid which, in future, contracts have been entered into for a much greater number of ties than are necessary to lay down the entire track.

An agreement has been made with the contractors to lay all of the unfinished portions of the road-track—to place additional force on any unfinished work on the line of the road, that may without such aid retard their progress in track-laying, and to complete the whole by the first of December next.

Seven additional locomotive engines, four first class and two second class passenger cars, three baggage and eighty freight cars, have been purchased, to be delivered before October next. An additional number of passenger, baggage, and freight cars, will be necessary to accommodate the traffic of the road by the time the track is completed, and contracts should be made for them at an early day to insure their delivery by the time they will be required.

Payments on all contracts entered into during the past fiscal year, for constructions and equipments, are payable in whole, or in part, in the mortgage, or income bonds, of the company, with the exception of the contract for iron rails.

Freight buildings, with platforms of suitable dimensions, for the reception and protection of freights, have been erected at all stations on that part of the road now in operation. Houses for the accommodation of passengers should be constructed at all important stations, at as early a time as the means of the company will permit.

Arrangements have been made for the erection of a brick engine house at Canton, and a freight house at Grenada. Freight houses will have to be built during the present year at the several stations on that part of the road not yet completed.

The work of construction, during the past fiscal year, has not been prosecuted with the degree of energy desired by the Directory, or that your interest demanded, in consequence of the inability of the Directory to command, in the early part of the year, the necessary amount of funds required for that purpose. At no time has the work been suspended, but to enable the Directory to comply with their engagements to contractors, with the limited means at their command, they were compelled to reduce the quantity of work to be executed to the smallest possible amount that would satisfy those who had undertaken it, and to decline putting other work under contract unless it could be done on the most favorable terms of payment.

Circumstances beyond the control of the Directory, prevented the delivery and the laying down as early as expected at the date of my last annual report, the fifteen hundred tons of iron rails purchased in the early part of last year. It was then expected the track would be extended to Coffeeville and Durant by the first of October, but in consequence of the delay in the delivery of the iron, it did not reach those points until about the first of January last; a period when the best business portion of the year had passed, and thus materially lessening the anticipated earnings of the road.

The amount expended by the company for construction and equipment of the road from its organization to the expiration of the fiscal year, now just closed, has been as follows:

On account of construction, including engineering, grading, bridging, superstructure, right of way, salaries, and other incidental exp'ses.	$2,729,545 73
On account of depot grounds and buildings, machine shops, tools, engine houses, locomotives, passenger, freight, and other cars....	332,273 60
On account of discount on company and other bonds, int. on funded and floating debt.....	334,145 53
Conducting transportation, repairs to equipments, and maintenance of way, for the past fiscal year.....	112,213 82
Total expenditures.....	$3,508,178 68

This sum has been derived from the following sources:

Amount received on account of capital stock.....	$1,641,947 72
Amount rec'd from net earnings of the road to May 1st, 1858.....	106,295 54
Amount rec'd on account of interest	148 32
" earnings of the road for the fiscal year ending April 30th, 1859	239,585 54
Amount of funded debt of the company.....	1,346,362 67
Amount of floating debt of the Company.....	383,129 94
Total receipts.....	$3,717,469 73
Remaining in the hands of the treasurer, cash--bills receivable—and other cash assets, to the amount of.	$209,291 05

From the foregoing expenditures of $3,508,178 68, for construction and equipments, should be deducted $317,871 84 discount on the company and other bonds sold, and the interest since paid thereon, which would leave $3,190,306 84 as the actual cash expenditure for construction and equipments.

The funded debt of the company consists of the following items:

Amount of first mortgage seven per cent. bonds sold.....	$1,007,363 60
Amount of income ten per cent. bonds sold.....	91,200 00
Amount of Tennessee State six per cent. bonds.....	45,000 00
Loan of Chicaksaw school fund from the State, bearing eight per cent. interest.....	181,850 00
Loan of three per cent. fund from the State without interest.....	20,949 07
Total funded debt.....	$1,346,362 67

The Floating Debt is comprised of the following:

Bills payable, becoming due during the present and succeeding year..	$249,443 98
Balances due to contractors and others	120,790 86
Balances to become due to contractors on completion of contract.....	12,895 10
Total Floating Debt.....	$383,129 94

Of the amount of bills payable, the sum of $99,257 92 has been issued in payment of iron rails and engines. And this amount will be considerably increased on the arrival of iron now in transitu. About half of the aggregate amount of bills payable now outstanding, are payable during the present year, and the residue will become due during the following year.

To liquidate the Floating Debt, provide for interest on the Funded Debt, and to prosecute the work of construction and equipment of the road, the company possess the following assets:

Funds in the hands of the Treasurer.....	$209,291
Balance due from the State on account of Chickasaw school fund loan.....	18,150
Balance to become due from the State on account of Internal Improvements. Land invested in the capital stock of the company (estimated).....	65,000
To be derived from loan of three per cent. fund from the State.....	20,000
First mortgage, seven per cent. bonds unsold.....	342,500
Income ten per cent. bonds unsold.....	408,800
Balance due on reliable subscription to capital stock.....	930,000
Total assets.....	$1,156,741

To these assets should be added the prospective earnings of the road during the present fiscal year. Past experience has confirmed me in the opinion that the estimate in my last annual report of a net annual income of $680,000 would be realized from the operations of the road after its completion, is not an exaggerated one. The local traffic of that part of the road operated, has exceeded the estimates, and the most productive districts to be traversed by it has not yet been penetrated. The aggregate earnings of the road during the present year must depend in a great degree upon the time when the track is completed. If this is accomplished before the commencement of the next business season, as is now anticipated, the earnings will be very large; if not effected until the beginning of the next year, they will be materially lessened by the delay.

The interest of every stockholder will, therefore, be promoted by extending every possible aid to secure the speedy completion of the road.

Taking the operations of the past year as a basis of an estimate, and the first of January, 1860, as the time when the entire road will be in working condition, the net income of the road for the present fiscal year will not be less than $325,000.

From this income must be taken the following items:

Interest on 7 per cent. Mort. Bonds sold..	$70,500
" " 10 per cent. Inc. Bonds sold ..	10,000
" " $45,000 Tenn. State Bds. 6 per cent.....	2,700
" " Chickasaw School Fund Loan.	14,500
" " Floating debt (estimated).....	15.000
Total interest to be paid	$112,700

There remains $212,300 of the estimated net income to be added to the other assets of the Company, making an aggregate amount of $1,369,041 05—less any loss that may be sustained on future sales of bonds—applicable to the payment of the floating debt, and the construction and equipment of the road.

If the net earnings of the road, after completion, equal, or approximate the estimates heretofore made, and the assets of the company, exclusive of the mortgage and income bonds, are realized during the present and succeeding year, it will enable the company to discharge all of its present floating debt, pay the cost of completing the road, and for all materials necessary for that purpose, and supplying the road with all necessary buildings and equipment, without a sale of any additional amount of the securities of the company, or, if a sale of the income bonds should be effected, to expedite the completion and equipment of the road, its future earnings will supply the necessary means to retire them before they become due and payable.

I also submit the report of the Treasurer, exhibiting the receipts and disbursements of his department during the fiscal year.

At the date of his last annual report there was remaining in his hands funds to the amount of		$36,036 82
Since that time he has received on account of subscription to capital stock.		66,473 72
On account of interest		148 32
On account of sales of 1st mort. bonds of the company		517,718 07
On account of sale of income bonds		91,200 00
On account of sale of personal property		2,365 25
On account of earnings of the road from transportation of freights, passengers and mail		239,585 54
Total receipts		$953,527 72

DISBURSEMENTS.

On account of construction, materials, expenses, salaries, &c		$426,805 23
On account of equipments, water stations, &c		90,107 57
On account of discount, interest on floating and funded debt, &c		64,885 67
On account of floating debt		50,224 38
On account of operating expenses of the road, repairs of road, engines and cars		112,213 82
Total disbursements		$744,236 67
Remaining in the hands of the Treasurer, cash and other available assets		209,291 05
		$953,527 72

The earnings of the Northern Division of the road for the fiscal year were derived from the following sources:

PASSENGERS.

22,330 passengers going north		$32,969 62
24,282 " " south		37,183 51
News agency		160 00
		$70,313 13

FREIGHTS.

14,168 tons going north	$44,315 67	
12,408 " south	50,310 00	
		$94,646 77
United States Mails		14,198 07
Total receipts		$179,157 97

The expenditures have been:

Conducting transportation	$36,587 66	
Motive power	7,808 65	
Repairs of cars	9,965 79	
Maintenance of way	31,924 85	
Total expenses		86,285 00
Net earnings		$92,872 97

The proportion of expenses to gross earnings has been 48½ per cent. It is proper, however, to remark, that a portion of the expenses included in the above items were incurred during the previous year, and by an inadvertency were omitted in the operating expenses of the year to which they were chargeable.

The expenses of operating the Northern Division, with its heavy grades and deep sandy cuts, and consequent liability to abrasion from rains, will for many years exceed those of the Southern Division, where the grades are light and but few excavations.

There have been carried in the cars on the Northern Division, during the year, 46,612 passengers and 52,738 bales of cotton.

The earnings of the Southern Division have been derived from the following sources:

PASSENGERS.

9,476 pass'gers going north	$11,186 03	
9,124 " " south	10,547 35	
		$21,733 38

FREIGHTS.

Freight going north	$14,014 00	
" " south	19,213 53	
		33,227 53
United States Mail		5,466 66
Total earnings		$60,427 57

The expenditures have been as follows:

Conducting transportation	$9,610 23	
Motive power	7,634 19	
Repairs of cars	944 31	
Maintenance of way	7,848 14	
		26,036 87
Net earnings		$34,390 30

being 57 per cent. of the gross receipts.

There have been 18,597 passengers carried in the cars on the Southern Division, and 33,793 bales of cotton transported.

The gross earnings of both Divisions of the road have been:

From passengers		$92,046 51
" freights		127,874 30
" United States Mails		19,664 73
Total earnings		$239,585 54

The operating expenses have been on the

Northern Division	$86,285 00	
Southern "	26,036 87	
Total expenses		$112,321 87
Net earnings		$127,263 67

There have been carried on the cars, during the year, 65,209 passengers, and 86,531 bales of cotton. It has not been claimed that the road, when fully completed and equipped, would transport more than 150,000 local passengers, and 125,000 bales of cotton. Yet, during the past year, on an average length of 107 miles of road, more than two-thirds of the number of bales of cotton claimed for 188 miles, and nearly one-half the number of local passengers have been transported. The net earnings have been about $1,200 per mile operated, or seven per cent. on entire cost when finished, and will be $3,500 per mile when completed and fully equipped.

Had the track of the road been extended to Durant and Coffeeville by the first of October last, as was expected at your last meeting, the receipts would have been increased fully fifty thousand dollars.

The following is the amount of equipments now on the road: 11 locomotives, 6 passenger and 3 baggage cars, and 152 freight and construction cars.

The report of Mr. Robert Sterling, Chief Engineer, is also submitted. Mr. Sterling estimates the cost of preparing the unfinished portions of road-bed between Coffeeville and Durant, and laying down the superstructure, at $268,141 13. In this sum is included all buildings that will be required between the points named.

The ascertained and estimated cost of the Northern Division of the road, extending from Grand Junction to Grenada, a distance of 99.94 miles, including all necessary buildings at the termini, as well as on the line of road—repair shops, bridges, masonry, iron rails, and other materials and labor of construction, at $18,609 05 per mile of road. The ascertained and estimated cost of the Southern Division, extending from Grenada to Canton, a distince of 88.27 miles, including all buildings required on the line and at Canton, iron rails and labor, at $16,907 26 per mile, making the average cost of the whole road $17,758 15 per mile, exclusive of equipments.

If the cost of equipments, now on the road, with that for which contracts have recently been made, including the estimated cost of what will be required by the time the track is finished, are added, then the ascertained and estimated cost of the road, when completed, with all necessary buildings and equipments, will be $19,935 per mile of road. The substitution of masonry for the present wooden structures should be adopted at as early a period as possible, and thus secure a more permanent way than you have at present. In all repairs of bridges, timber should be discarded and more durable materials adopted.

An agreement has been made with the Mississippi Central and Tennessee Railroad Company for the consolidation of that Company with yours under the name and style of the Mississippi Central Railroad Company, in accordance with the provisions of the charter of the respective companies. The Mississippi Central and Tennessee Railroad is forty-eight miles in length, extending from Grand Junction to Jackson, Tenn., where it intersects the Mobile and Ohio Railroad. It has been well and economically constructed; is in good repair, and well supplied with equipments.

The consolidation has been in contemplation from the time of the organization of the Tennessee Company, and when finally consummated, will constitute a road of two hundred and thirty-six miles in length under the supervision of one Board of Directors. The employees of the respective companies may be reduced in number, and the ordinary expenses of the separate companies diminished by consolidation, and the earnings of the united roads may be increased without a corresponding increase of traffic from the greater distance that freight and passengers may be transported, a unity of interests with uniform rules of management, and avoidance of trans-shipment at Grand Junction, will insure a greater economy in operation, and have a tendency to increase the amount of both passenger and freight traffic. The capital liabilities and property of the respective companies will become the capital liabilities and property of the consolidated company.

The cost of the forty-eight miles of road, including equipments, station buildings, work shops and real estate, has been $1,023,469 99, or $21,322 per mile. This amount was derived from the following sources:

Subscript'n to the capital st'k of the Co.		$309,562 26

FUNDED DEBT.

Six per ct. bonds of the State of Tenn.	$529,000 00	
Company bonds sold	95,500 00	
		$624,500 00

FLOATING DEBT.

Bills payable	$16,721 03	
Due individuals and other roads	43,521 52	
		$60,242 55
Net earnings of the road		58,417 21
Total receipts		$1,052,722 02
Less cash and other reliable assets on hand, exclusive of $14,737 74, due on subscription to the capital stock of the company		29,252 03
Total cost of road and equipm't.		$1,023,469 99

The assets of the company are as follows:

Cash on hand	$4,702 47
Due from agents, connecting roads and individuals	14,388 51
Bills receivable	5,551 25
United States Post Office Department	5,159 80
	$29,252 03

To this sum should be added amount due on subscription to

Capital stock	$14,737 74
Total assets	$43,989 77

The net earnings of the road for the year ending April 30th, have been $43,436 31.

The property of this company, exclusive of road, station buildings, work-shops and office furniture, is as follows: 4 locomotives; 3 passenger, 2 baggage and 46 freight cars; 1,000 acres of timber land on the line of road.

Chicago, Burlington and Quincy Railroad.

At the annual meeting of the stockholders of the Chicago, Burlington and Quincy Railroad Company, held in Chicago, 24th ult., the following Board of Directors was chosen: John Van Nortwick, Batavia, Ill.; Chauncey S. Colton, Galesburg, Ill.; Isaac H. Burch, Chicago; Jas. F. Joy, Detroit; Erastus Corning, Albany; Edward C. Baker, New Bedford, Mass.; John M. Forbes, John W. Brooks, Samuel R. Spinney, Robert S. Watson, William Boott, Boston.

Mechanics, Physics, and Chemistry.

On the co efficients of Elasticity and Rupture in Wrought Iron, in relation to the volume of the metallic mass, its metallurgic treatment, and the axial direction of its constituent crystals.
By R. MALLET, M. Inst. C. E.

It was assumed that amidst the numerous theoretical treatises upon, and practical investigations into, the strength and other properties of iron, the two questions which formed the prominent features of the author's present experimental inquiry, had remained comparatively untouched. The conditions of manufacture and the resultant qualities had been hitherto too lightly passed over.

Iron was formerly entirely worked under tilt hammers; the process of rolling was then introduced, and now, in consequence of modern engineering requirements, masses of iron of considerable magnitude were produced by faggoting together, under heavy forge hammers, from large numbers, either of bars or slabs grouped together. The masses were not, however, found to possess ultimate strength in proportion to the number of bars of which they were composed; in fact, it appeared that the strength of the mass became less in some proportion as the bulk became greater. This was admitted as a fact, but no one had hitherto attempted to show, experimentally—what function of the magnitude was the strength of a given kind of iron, manufactured in a given manner; or how the same forged mass, when very large, differed in strength in different directions with reference to its form; or how the mechanical part of the process of manufacture of the same iron affected its actual strength, either as a rolled bar or forged mass.

Addressing himself to this investigation, the author dealt generally with three points of the inquiry, viz:

1°. What difference did the same bars of unwrought iron afford to forces of tension and of compression when prepared by rolling, or by hammering under a steam hammer?

2°. How much weaker per unit of section, was the iron of very massive hammer forgings than the original iron bars of which the mass was composed?

3°. What was the average or safe measure of strength per unit of section, of the iron composing such very massive forgings as compared with the acknowledged mean strength of good British bar iron?

In the investigation of these questions other subordinate but very important points arose; such as the determination of the relative longitudinal and circumferential strength of equal sections of the iron in massive cylindrical forgings.

The proper measure of the strength of iron, or any imperfectly elastic material, was the "work done," whether by extension, compression, rupture, or crushing, due to any force applied to it. The co efficients *Te* and *Tr* were designed by Poncelet to express this work done by an extending or compressing force upon any elastic prismatic body at the point where its elasticity became permanently impaired, and its form distorted, and at the further point where rupture occurred. The method of arriving at these co-efficients was then given, and it was shown that, though they were not sufficiently attended to in practice, yet that they were the true measures of the safe and ultimate resistance of materials when applied constructively in machines or otherwise.

The crystalline structure of iron was then considered, and quoting from the author's communication to the Royal Irish Academy (*Trans.* vol. 55, p. 1, 1855), it was shown to be a law that "Iron, whether in the state of cast or of wrought iron, has the principal axes of its integrant crystals arranged in the lines of least pressure within the mass."

If consolidation from fusion took place undisturbed, as in cast iron, the principal axes would be arranged in the directions in which the heat-wave had passed outwards from the body in cooling; which would be perpendicular to its surface contour—those being the direction of least pressure of the internal constraining forces, produced by contraction in cooling, which were necessarily parallel to the planes of external contour.

The effects of rolling and of hammering masses of wrought iron of different contents were then treated of, and it was shown that what was termed "fibre" was the longitudinal extension of the principal axes of the crystals. The original development of these crystals, under the constraining forces due to temperature, &c., was "cæteris paribus" proportioned to the time given for such development. Thus, in very large forgings the crystals were generally extensively developed, in consequence of the length of time which the mass had been under the operations of heating and forging.

It had long been admitted that large forgings became weaker in proportion as their bulk was increased, but as no definite ratio was recognized it became of importance to fix the conditions of strength in wrought iron under various circumstances. The author was enabled to undertake this investigation, under the authority of the Minister of War, and with the concurrence of the Royal Society, when making the forgings for the two 36-inch wrought iron mortars constructed on his design for the Government; he then selected specimens of iron upon which the experiments of tension and compression were tried.

The methods were then explained by which the specimens of iron were obtained from large masses, and the apparatus was described by which the observations were made, when the specimens were undergoing the operations of extension and compression. In cutting and boring into the massive cylindrical forgings to obtain the pieces of iron from the various parts, it was invariable found that there existed internally large transverse rents, with jagged and crystalline irregular surfaces, the opposite faces of which were counterparts, and presented distinct evidences of having been torn asunder by contraction from the centre towards the circumference as the mass cooled. The *rationale* of the phenomenon appeared to be, that this action was simply due to the contraction of the external shell before the temperature of the centre had been perceptibly lowered; this, in its turn, was cooled, and in contracting produced these visible rents or fissures, and, no doubt, caused other minor dislocations, which detracted from the general strength of the mass.

This was evidently the cause of the difficulty of obtaining very large forgings of a cylindrical form quite sound; as if the diameter was sufficiently great, all such cylindrical forgings so built in construction, and so treated by heating, hammering, and cooling, in manipulation, must become unsound internally by the opening within the mass of one or more of these rents in the direction of the axis during the process of cooling. In solid cylinders, or conic frustra, it must occur whenever the dimensions were such that the total amount of contraction of the metal in any one diameter from its highest temperature down to that of the atmosphere, as fixed by the circumference of rigidity due to the outer cold shell, exceeded the limit of tension of the iron at rupture due to the length of the diameter of the interior core, which cooled last. This was the theoretic limit of size of forging, beyond which internal rents must occur. The practical illustration was, that almost all cylindrical shafts of wrought iron exceeding 12 inches in diameter were found to have one or more of these rents in them, thus having their strength impaired. This reduction of strength was altogether distinct from any deterioration of quality of the metal, arising from its being alternately heated and cooled and hammered.

The remedy for this play of molecular forces was to construct and work the large forgings hollow. This course had been pursued with success at the Mersey Iron Works, Liverpool. When a cylinder had a large concentric cylindrical hole along its axis, it cooled at the same time, though not equally, on both the internal and external surfaces, and thus the extremes of internal streams were avoided, and the hollow centre yielded more readily to the forcible compressive grasp of the exterior.

A minute description was then given of all the irons which had been experimented upon, specimens of each being exhibited at the meeting. They were divided into classes according to their several characteristics and modes of working, and into the most analogous class was imported Clay's puddled steel, a comparatively new material, which had been brought into this investigation for the purpose of comparison, and the results were such as promised to be of great practical importance. The general results were the separation of several classes into two grand divisions: 1°. The crystalline, or sub-crystalline in fracture, which were always the result of manufacture by the hammer. 2°. The fibrous, or crystallo-fibrous, which were always produced by the rolling process, but which might be produced by careful and continuous elongation under the hammer.

The very weakest wrought iron of all those experimented upon was found to be that cut transversely from the end of a very heavy cylindrical forging, which had been exposed to heat and percussion for nearly six weeks. Exposed to tension its elastic resistance was only 3¼ tons per square inch, which was less than the average of cast iron; thus, as regarded pressure, it was the very weakest iron produced by any method of manufacture; whilst the faggot bars of which the mass was built and welded up, bore a tension of upwards of 12 tons per square inch before losing their elasticity, and of nearly 23 tons at rupture, and a pressure of nearly 21½ tons before losing elasticity, and of nearly 27¾ tons at the point of total distension or crushing; thus proving the fact that the extreme weakness of wrought iron in heavy forging was not due to any metallurgical alteration in the constitution of the metal, but to changes in its state of aggregation, induced by a process of forging, by the long-continued and unequal heating, and by the hammering.

Hence was deduced the conclusion, that practically the iron of very heavy shafts, forged guns, huge cranks, and other similar masses, might be expected to become permanently set and crippled at a trifle above 7 tons per square inch, and to give way, by fracture, at about 15 tons per square inch by tension, and to completely lose form at pressures of from 15 to 18 tons per square inch. Therefore, it followed, that allowing a deduction of one-half, as sanctioned by practice, from the elastic limits of tension, and of pressure, for the margin of safety, the iron of such forged masses should not be trusted for impulsive strains exceeding about 1¾ tons per square inch of tension, and about 4½ tons per square inch of pressure, or for passive tensile-strains of 3½ tons per square inch, or for passive pressure beyond 9 tons per square inch.

Further experiments demonstrated that in heavy rectangular forged slabs of upwards of 12 inches in thickness, in the plane of the slab, the resistance to all the forces was much higher, and hence large cranks, which were usually cut out of such rectangular forgings, were stronger than the shafts to which they were attached, in the ratio of 8 to 6. The physical cause of the difference in strength between large cylindrical and rectangular forgings, although made from the same original material, was to be found in the difference of the molecular arrangement. The integral crystals of the cylindrical masses were stained, distorted, and partially separated, by the effects of hammering in various directions, and by the peculiar constraining forces due to the contraction in cooling; whereas, none of these forces acted to the same extent upon rectangular masses, which were only hammered in three directions, and the constraining forces of cooling were all parallel to the faces of the parallelopiped, or in three directions only.

A special peculiarity noticed in heavy forgings was the sudden and extreme inequalities of texture and of strength found in different and even in closely adjacent portions of the same mass, producing greater uncertainty of result in practice.

Another peculiar feature was, that the rates of extension, or of compression, did not move uniformly, but by fits and starts. This phenomenon obviously arose from the *per saltum* disintegration

of planes of crystallization, and their more or less complete separation in a crystallized, but yet ductile body. This had never been observed in fibrous irons, or in those in which the finely elongated crystals were all rolled parallel, and in the line of the length of the bar, or of the sheet.

If the original, or integrant, faggot bars, from which a heavy forging was built and welded up, and a tensile elastic strength of 12 tons per square inch, the forged mass itself would have a mean tensile elastic strength of only 7 tons per square inch; and correspondingly if the faggot bar had a compressive elastic resistance of 2½ tons, the forged mass itself would range under 18 tons per square inch.

Thus, within the limits of practice, the work of passive resistance, sustainable by heavy forgings, was about one-half that of the faggot iron from which they were manufactured; but at the ultimate point of rupture they gave a better result. Heavy forgings were also more trustworthy when exposed to tensile strains in direction of their length, or to transverse strains, as in girders, which ultimately were resolved into longitudinal strains, than when subjected to twisting strains, as in shafts, or to direct pull across the direction of length.

These, and other considerations, induced attention to the apparently superior power of puddled steel to support the forces by which the ordinary forged masses of wrought iron were fractured, es pecially as by the employment of smaller and lighter masses, greater strength in shafts, &c., could be secured. One special peculiarity appeared to be, that in the heaviest pieces of this material the internal structure was as fine and close in the grain as it was in the smallest bar. The elastic limit was above that of the best wrought iron, and the elasticity was so much more perfect, that it might be trusted almost up to the elastic limit of about 15 tons per square inch, and in forged masses it possessed this strength nearly equally in every direction. The range of extension at the elastic limit was rather greater than that of fibrous hammered bar iron of excellent quality. Beyond the elastic limit, with equal increments of strain, its extension did not rapidly diverge and increase, as in wrought iron; it slowly increased up to about 20 tons per square inch, and gradually and evenly enlarged up to the breaking point, which was not reached within 42 tons per square inch, and was often found to reach 48 tons per square inch.

This puddled steel was not like cast steel, a harsh, rigid, and glassy material, which possessed, indeed, enormous cohesion, but yet was so rigid and unaccommodating to forces variable in direction, and impulsive in character, as to deprive it of trustworthiness in practice. On the contrary, puddled steel appeared to combine the great strength of cast steel with ductility, and perfect elasticity, of the best wrought iron. Its resistance to pressure was very remarkable, being more than double that of harsh crystalline wrought iron, and more than three times that of the best fibrous wrought iron in bars or plates. Thus, it may be safely used under a passive strain, or load, of 20 tons per square inch, after allowing a margin of one-half for security.

Puddled steel would thus evidently become an important practical adjunct in the construction of machinery, in building vessels of light draft of water, and for artillery of the largest calibre. It possessed also the peculiarity of resisting corrosion much better than wrought iron plates, and thus had an additional value for ship-building.

An investigation was then entered into of the causes of the manifestly greater strength of the integrant slabs than of the large forgings built up from them; but it was shown that this quality did not extend to the boiler-plates which it acquired a certain amount of rigidity. This was also possessed by the puddled steel, and it was anticipated that it would ultimately be extensively employed for the boilers, and even the fire-boxes of the locomotive boiler.

From this investigation nothing of a certain character could be concluded as to any fixed relation between the strength and the specific gravity of the several sorts of iron experimented upon. The weakest irons—those from the heavy forgings—having generally the highest specific gravities, though always lower than their integrant faggot bars. Thus, it appeared that specific gravity was a characteristic to which too great importance had hitherto been attached in relation to strength both in cast and in wrought iron. It was modified, increased, or diminished, by the mechanical operations of manufacture to an extent far beyond anything that chemical difference of constitution produced, and, in reality, it afforded no criterion of strength, although in fibrous irons it did afford an index of their degree of extensibility for equal size.

The modulus of elasticity deducible from these experiments, from the mean results of the great forgings, was 12,559,680 lbs., or 3,771,675 feet for iron forged in great cylindrical masses. The mean specific gravity being taken at 7,663, the weight of 1 foot long by 1 inch square of this iron was 3.33 lbs. The modulus for great forged rectangular masses or slabs was 18,079,200 lbs., or 5,478,545 feet; the specific gravity being 7,610, and the weight of a bar 1 foot long and 1 inch square, 3.30 lbs. Both fell far below the modulus for good English bar iron of 7,550,000 feet as deduced by Tredgold, or even below 6,787,878 feet as deduced by Edwin Clark from Eaton Hodgkinson's experiments.

The author concluded his paper by recording the obligations he was under to Messrs. Horsfall, and to Mr. Clay, of the Mersey Steel Works, Liverpool, and to the officers of the War Department, and Royal Arsenal, Woolwich, for the facilities afforded to him during his investigation.—*C. E. and Art Jour.*

Pennsylvania Railroad.

This company is sparing neither expense nor labor in providing the necessary facilities for their largely increasing business, and the comfort and convenience of their patrons. They are now erecting at the Gap, Parkesburg, and other places along the line of the road, new and extensive warehouses or freight depots. The new buildings are brick, are to be large and commodious, and to be constructed in the most substantial manner. Other improvements are contemplated when these structures are completed. The wooden bridge across Mill Creek is to be superseded by an iron one, and the work has already been commenced. Within a short time, we understand, the company will commence straightening the track, and tearing down the old buildings in Lancaster, preparatory to the erection of the new depot in that city. The work is now being under the supervision of J. C. Sharpless, the Assistant Engineer of the company. All the buildings put up by this company have been of the most substantial and beautiful kind; but this one, it is said, will surpass all others. The management know how to please the public—in fact it would be difficult to find anybody who know the wants of persons who patronize railroads, as J. Edgar Thomson, Wm. B. Foster, Jr., and Thos. A. Scott, and while they continue to administer the affairs of the Pennsylvania Railroad Company, stockholders, business men, and travelers in general, need not fear of having their interests properly attended to.—*Phila. Evening Journal.*

Camden and Atlantic Railroad,

The annual meeting of the stockholders of this road was held recently, when the following gentlemen were elected directors for the ensuing year: John Brodhead, Stephen Colwell, Wm. Schmœle, Andrew K. Hay, Joseph Porter, Jonathan Pitney, William Coffin, Enoch Doughty, Francis M. Drexel William B. Foster, Jr., A. J. Antelo, John Clement, and Thomas McKeen. The last five, though new directors, are not unknown to the public, and will tend considerably to strengthen the present very efficient management. John Brodhead, the gentlemanly and energetic President, was re-elected.

TREATISE

ON THE

PRINCIPLES OF CIVIL ENGINEERING

AS APPLIED TO THE

CONSTRUCTION OF WOODEN BRIDGES.

By S. S. Post, *Civil Engineer,*
And late Chief Engineer of the N. Y. & Erie R. R.

(Continued from p. 405.)

The effective blow of the ram is the consequence of its momentum, and the rule given by mathematicians to ascertain the momentum is, to multiply the *weight* of the body by its velocity in *feet per second.*

This rule is unquestionably correct in comparing the forces of two or more moving bodies, but not in comparing the force of pressure of a body at rest, with the force of a body in motion. For it is self-evident that the force of a body in motion cannot be *less* than when it is at rest. Suppose the weight of a body to be 1,000 lbs. and to fall a distance of 0.01 of a foot. By the rule given, the velocity acquired will be $2\sqrt{0.001\times16\frac{1}{12}}=0.802$ of a foot per second, and the momentum $1{,}000\times0.802=802$ lbs, a result that cannot be true.

The writer has been unable to find an account of any experiments which satisfactorily determine the true relations existing between an active force and a dead weight.

It is said that, according to an experiment made by Mariotte, a body weighing 2.27 lbs. falling 0.59 of a foot produced a shock equivalent to a pressure of 430 lbs.; but there must be an error in the translation, or, otherwise, an exaggeration in this statement.

By Mr. Bevan's experiments "the percussive force required to drive the common six-penny nail to the depth of *one inch and a-half* into dry Christiana deal, with a cast iron weight of 6.275 lbs., was *four* blows or strokes falling freely the space of *one foot:* and the steady pressure to produce the same effect was 400 lbs."

The data sought for estimating the weight which may be allowed to repose upon a pile, not being within reach from other sources, the writer has had recourse to such means as were immediately at hand to ascertain, approximately, the real value of the force, or shock of the ram as compared with its weight.

The experiments here alluded to were made with a Salter's improved spring balance, graduated to only 24 lbs. The scale was tested and corrected for every half pound by the application of weights from half a pound upward—the weights from Fairbank's small scales being used for the purpose. These weights are slotted on one side to the centre and can be conveniently attached to a string. The cord used to suspend the weights was of hemp, about $\frac{1}{14}$ of an inch in diameter.

The experiments were made by letting one pound fall one foot and noting the degree on the scale indicated by the pointer; then by letting it it fall 2 feet, and 3 feet. After which a half pound weight was attached and allowed to fall successively 1 foot, 2 ft., 3 ft., etc. to 9 feet. The index of the balance was made to register the force by means of beeswax applied to the plate on which the degrees were marked.

Each experiment was repeated five or more times and the mean result taken.

The weights indicated by the first series of experiments were as follows:

1	lb.	falling	1	foot	indicated 13½ lbs.
1	"	"	2	feet	" 18¾ "
1	"	"	3	"	" 22½ "
½	"	"	1	foot	" 6½ "
½	"	"	2	feet	" 10 "
½	"	"	3	"	" 11½ "
½	"	"	4	"	" 13 "
½	"	"	5	"	" 14½ "
½	"	"	6	"	" 16 "
½	"	"	7	"	" 18 "
½	"	"	8	"	" 18½ "
½	"	"	9	"	" 19½ "

Again repeating the experiment with a pound weight falling one foot, the scale indicated 13½ lbs. as before. The limb of the balance which acted upon the spiral spring had its lower extremity enlarged by a square offset, to allow a hole of sufficient size to attach the hook. By pressing down upon the hook a wedge could be inserted between the shoulder of this offset and the socket so that the pointer would indicate weight when none was applied.

On wedging the spring down to 13½ lbs. and letting the pound weight fall one foot, the pointer registered some sixteen pounds. On wedging the spring at 16 lbs. and letting fall the weight 17½ lbs. were indicated, and on wedging down to 17½ lbs. the pointer registered 18 lbs. very nearly. Wedging the spring at 18 lbs. and letting the weight fall, the wedge would drop, but no decided impression was made upon the wax, by the pointer. Here was clearly an absorption of 4½ lbs. by the elasticity of the spring. This series of experiments was continued with the following results:

1	pound	falling	1	foot	indicated	18	lbs.
½	"	"	1	"	"	9	"
½	"	"	2	"	"	12½	"
½	"	"	3	"	"	15½	"
½	"	"	4	"	"	17½	"
½	"	"	5	"	"	19½	"
½	"	"	6	"	"	21½	"

Comparing these two series of experiments it is found that the minimum increase is 25 per cent., the maximum 39 per cent., and the mean increase of force 33⅓ per cent.

The distance from 0 to 13½, on the graduated scale of the balance, was 0.095 of a foot, or at the rate of 0.007 of a foot per pound.

A momentum of 18 lbs. acting against a resistance increasing from 0 to 13½ lbs. in 0.095 of a foot, was thereby reduced one-fourth, and a proportional loss of force was sustained in each of the other cases.

An experiment to determine the quantity of elasticity of the cord, through the medium of which the weight acted upon the spiral spring was also made. A length of 5 feet was carefully measured and marked upon the cord, by which half a pound was already suspended. 20 lbs. were then added when the distance between the marks was increased 1.2 inches or 0.1 of a foot. On removing the 20 lbs. the length between the marks upon the cord was restored to 5 feet. The elasticity of the cord was therefore 0.001 of a foot per pound per foot, and one pound falling one foot with a force of 18 lbs. produced an extension of the cord of .018 of a foot or a little less than one-fifth of the compression of the spring.

The inference from this experiment is that if one pound falling one foot lost one-fourth part of its momentum on account of the elasticity of the steel spring, it also lost one-fifth as much, or one-twentieth part of its momentum by the elasticity of the hempen spring or cord. And if the inference be correct *one pound falling one foot will produce a shock which will be equivalent to a pressure of* 18.9 *lbs.*

The velocity acquired by a body falling one foot was found to be at the rate of 8.02 feet per second. If this velocity be multiplied by 2.36 times the weight in lbs. the result for one pound will be $1\times2.36\times8.02=18.9$.

As the momentum can never be less than the weight, that weight should be considered as a constant quantity, to be added to a variable quantity which increases as the motion increases, the sum of these two quantities being the amount of force produced. The variable quantity will be a function of the constant quantity or weight multiplied by the velocity. For instance, the momentum of 1 pound falling 1 foot may be expressed thus:—

$$1+(3\times2.23\times8.02)=18.9 \text{ lbs.}$$

Collecting the experiments into one table adding to the second series one-twentieth of its indicated force,—for the effect of elasticity of the cord,—and comparing the results with those obtained in accordance with the expression just given, they will be as follows:

Weight in lbs.	Fall in feet.	Velocity acquir'd p'r second in feet.	Weight in lbs. registered in 1st series of experiments.	Weight in lbs. registered in 2nd series of experiments.	Weight in lbs. corrected for elasticity of the chord.	Weight in lbs. as per calculation.
1	1	8.02	13½	18	18.90	$1+(1\times2.23\times 8.02)=18.90$
1	2	11.34	18¾	..	.....	....
1	3	13.90	22½	..	.....	....
½	1	8.02	6½	9	9.45	$\frac{1}{2}+(\frac{1}{2}\times2.23\times 8.02)=9.45$
½	2	11.34	10	12½	13.12	$\frac{1}{2}+(\frac{1}{2}\times2.23\times11.34)=13.14$
½	3	13.90	11	15½	16.27	$\frac{1}{2}+(\frac{1}{2}\times2.23\times13.9)=16.04$
½	4	16.04	13	17½	18.37	$\frac{1}{2}+(\frac{1}{2}\times2.23\times16.04)=18.38$
½	5	17.93	14½	19½	20.47	$\frac{1}{2}+(\frac{1}{2}\times2.23\times17.93)=20.49$
½	6	19.75	16	21½	22,57	$\frac{1}{2}+(\frac{1}{2}\times2.23\times19.75)=22.52$
½	7	21.22	18	..	.....	....
½	8	22.68	18½	..	.....	....
½	9	24.06	19½	..	.....	....

Applying these principles in estimating the *pressure* that, for a moment, will be equivalent to the shock of a ram weighing 1,000 lbs. and falling 25 feet, the result will be

$$1{,}000+(1{,}000\times2.23\times40.1)=90{,}423 \text{ lbs.}$$

When the fall is from 20 to 30 feet as it often will be in giving the finishing strokes, the *weight* of the ram will be small compared with its *force of motion*, and may be neglected, in which case the following rule may be adopted.

To estimate the force of percussion of the ram, multiply its velocity by 2¼ times its weight.

For a ram weighing 1,000 lbs. falling 25 feet, this rule will give $1{,}000\times2.25\times40.1=90{,}225$ lbs. as the force of percussion, or one-fifth of one per cent. less than the former result.

Opposed to the force of percussion of the ram, is the resistance to penetration of the pile. If there were no tendency to overcome the force communicated from the ram to the pile, the resistance to penetration would be equal to zero, or, if that force were 90.225 lbs. the resistance would be $\frac{90.225}{\text{Infinity}}=0$.

On the other hand, if the resistance were absolute, so that no penetration could be effected by any quantity whatever of force, then that resistance may be said to be infinite, and may be expressed by $\frac{90.225}{0}=\text{Infinity}$. But if the resistance is only relative and balances the force applied it will be represented by the expression

$$\frac{90.225}{1}=90.225.$$

The resistance to penetration, then, is inversely as the distance penetrated; the density and friction of the body penetrated being uniform. Thus a stiff clay will be less easily penetrated than a light loam, but a pile may be driven in loam, as well as in clay, to a depth so great as to resist further impact of a ram of given weight falling from a given height. In either case the product of the co-efficient of friction into the depth penetrated will be equal to the mechanical effect of the percussions.

EXAMPLE.

Suppose that a pile has penetrated a bed of clay, of uniform texture and indefinite thickness, to a depth of 20 feet, and that under the fall of a ram with a force of 90,225 lbs. it should be found to penetrate one foot more.

During the penetration of one foot, 20½ feet of the pile will be acted against on its sides by the friction of the clay. This friction is at the rate of $\frac{90,225}{20.5}=4{,}401$ lbs. per foot.

Consequently to sink the pile from 20 to 21 feet, required 4.401 lbs. more force than to sink it from 19 to 20 feet.

To sink the pile from 21 to 22 feet will require a force of $90{,}225+4{,}401=94{,}626$ lbs.; to sink it from 22 to 23 feet, the force required will be $94.626+4.401=99.027$ lbs.

The force of 90.225 lbs. with which the pile was sunk from a depth of 20 ft. to 21 ft., was due to a fall of 25 feet. For the next stroke the fall will be 26 feet, and the force of percussion will be

$$2\sqrt{26\times16\tfrac{1}{12}}\times1{,}000\times2\tfrac{1}{4}=40.9\times2{,}250=92{,}025$$

lbs. The force of this blow is, then, 1,800 lbs. greater than the one immediately preceding it, and the depth it will sink the pile, will be

$$4.401:1{,}800::1:0.409 \text{ of a foot.}$$

The force of the next stroke will be

$$2\sqrt{26.409\times16\tfrac{1}{12}}\times1{,}000\times2\tfrac{1}{4}=41.22\times2{,}250=$$

92,745 lbs. or 720 lbs. greater than the next preceding blow.

The depth sunk by the last stroke was 4,401 : 720 :: 1 : 0.164 of a foot. The next stroke will be $2\sqrt{26.573\times16\tfrac{1}{12}}\times2{,}250=41.35\times2{,}250=$ 93,037 lbs. or 292 lbs. of augmented force, which will give an increased depth to the pile of 0.067 of a foot; for 4,401 : 292 :: 1 : 0.067.

At a fall of about 26¾ feet the force of the ram will only equal the resistance of the pile,

without motion,—and the interruption will not be overcome unless the ram can be made to fall from a greater height by elevating the machine, or by otherwise increasing the force.

In this example the earth was supposed to offer a uniform resistance for the whole depth. In practice, soils varying in density and friction, will be most likely to occur.

When first driven, the earth immediately surrounding the pile will be compressed into less space than it before occupied, but in time the particles so compressed will be relieved by reaction upon the surrounding mass, and their pressure against the pile will be reduced. Water will find its way along the sides of the pile softening the surrounding material and acting as a lubricator. The driving a great number of piles within a short distance of each other has a tendency to shatter the soil, and the vibrations in consequence of the shocks tend to loosen it near the surface.

For these and other reasons the friction which resists penetration at first, cannot be relied upon to continue indefinitely to the same degree.

The cause tending to reduce the resistance to penetration, will generally be much more active near the surface than at a considerable depth.

It would be no more judicious to load a pile to the full extent of the force of the ram, than to load a beam to its ultimate strength; but it seems reasonable to conclude that the greater the depth penetrated, the less will the resistance be diminished from any cause, and consequently that the deeper the pile, the greater will be the proportionate weight it can safely be trusted to sustain.

On being driven 'home,' if the pile shall have penetrated but one or two feet for instance, it may not be safe to subject it to a permanent load of more than one-sixth or one-fifth of the force with which it was driven, while, if the penetration be 16 feet or more, it may be safely loaded with two-thirds, or, if the penetration has reached 30 feet, the load may perhaps be increased to nine-tenths of the effective momentum of the ram.

The base of the granite pier, § 100, was supposed to be 15 by 35 feet. If piles were to be driven for the foundation of such a pier, and placed 3½ feet from centre to centre, there would be five rows, of eleven piles in a row, or altogether 55 piles.

The weight of the pier was 2,620,833 lbs., and the half weight of the bridge 241,800 lbs.

If the pier be required to support two half spans on opposite sides, the whole weight will be 3,104,433 lbs., or 56,444 lbs. per pile. Or if only a half span rests upon the masonry as an abutment, the piles composing the rows on the side toward the span will be subjected to as great pressure for the same number of piles as in the case of the pier supporting two half spans.

To cover all the contingencies of extreme weight of locomotive, extraordinary concussions of wheels on the open joints of rails, and the tendencies to diminution of friction against the sides of the piles, a liberal allowance should be made. If 50 per cent. be deemed proper in this case, the pressure with which each pile must be driven, will be 84,666 lbs.

The momentum of a ram weighing 1,050 lbs. falling 20 feet will be—

$$2\sqrt{20}\times16\tfrac{1}{2}\times1{,}050\times2\tfrac{1}{4}=84{,}743 \text{ lbs.}$$

Massachusetts Railroad Dividends.

The following dividends are payable in July at the dates given in the margin. They are all for six months, except the Berkshire, which is quarterly. They are all payable in Boston, except the Providence and Worcester Railroad, at Providence, R. I., Worcester and Nashua at Worcester, and Stoughton Branch at Canton, Mass., at the several Treasurers' offices. The Boston and Maine has increased its dividend ½ per cent.; Stoughton Branch ½, and Boston and Lowell ½ per cent. on its regular payment, besides paying 1½ per cent. extra, as receipts from "disputed accounts." The Michigan Central will again pass its dividend. The Old Colony railroad bonds have all been paid off. Interest on a portion of the Eastern railroad 5 per cent. bonds due in 1862, originally negotiated in London, is now payable. The Michigan Central will pay in cash $256,000 of bonds maturing July 1st, which swells the total of the bond account.

Stocks.	Capital.	Div.	Am't.
Railroad Companies.			
11 Berkshire	$320,500	1¾	$5,609
1 Boston & Lowell	1,830,000	*5	91,500
1 Boston & Maine	4,155,700	4	166,228
1 Boston & Providence,	3,160,000	3	94,800
1 Boston & Worcester,	4,500,000	3	135,000
1 Fitchburg	3,540,000	3	106,200
1 Metropolitan (Horse).	450,000	5	22,500
1 Middlesex (Horse)	295,100	4	11,804
1 Old Col'y & Fall River	3,015,100	3	90,453
1 Pittsfield & N. Adams	450,000	3	13,500
1 Provid'ce & Worc'ster	1,550,000	3	46,500
1 Stoughton Branch	85,400	3½	2,989
1 Taunton Branch	250,000	4	10,000
5 Western	5,150,000	4	206,000
11 Worcester & Nashua	15,220 sh'rs	$2	30,440
			$1,033,523
* 3½ regular, 1½ extra.			
Interest on Bonds.			
1 Albany 6's Western	$1,000,000	3	30,000
1 Boston City Stock	Interest	..	135,000
1 Boston, Con. & Montr'l	About	..	11,000
1 Boston & Providence	About	..	3,000
1 Boston & Worcester	500,000	3	15,000
1 Cambridge (Horse)	150,000	3	4,500
1 Cheshire	700,000	3	21,000
1 Dorchester & Milton	25,000	3	750
1 East'rn 5's,'62,(in part)	150,000	2½	3,750
1 Essex	213,600	3	6,408
1 Massachusetts State	Interest	..	2,500
1 Do. (Eastern Loan)	Interest	..	8,750
1 Do. (Nor. & Wor. Loan)	400,000	3	12,000
1 Michigan Central	Interest	..	12,000
1 Michigan Central	Principal	..	256,000
1 Peterboro' & Shirley	40,000	3	1,200
1 Portland City	About	3	15,000
1 United States Loan	About	..	25,000
1 Vermont & Mass.	1,000,000	3	30,000
			$592,858

RECAPITULATION.

Interest on bonds	$592,858
Railroad dividends	1,033,523
Total July, 1859	$1,626,381
" January, 1859	1,431,387
" July, 1858	1,548,438
" January, 1858	1,296,392

The following dividends either have been paid recently, or are now payable:—

Companies.	Capital.	Div'd.	Am't.
Passumpsic railroad bonds	$725,000	3	21,750
Portl'd & Saco R. R. div'd	1,500,000	3	45,000
			$66,750

The total of dividends for July is larger than one year ago, but about the average previous to that time.

Cincinnati Stock Sales.

By KIRK & CHEEVER.

For the week ending June 27, 1859.

BONDS.	Per cent.	
Little Miami, 1st Mort.	6s	83 and int.
Covington and Lexington, 2d Mortgage	6s	50
Cinc., Ham. and Dayton, 2d Mortgage	7s	85
Indianap. & Cincinnati, do. do.	7s	85
STOCKS.		
Cincinnati, Hamilton & Dayton		63
Columbus and Xenia		83⅛
Indianapolis & Cincinnati		53
Little Miami		84
Ohio and Mississippi		2⅛

Railroad Earnings.

The May earnings of the Great Western railroad of Illinois were:—

May, 1859	$36,630 06
May, 1858	28,695 44
Increase	$7,934 62

On the Sandusky, Mansfield and Newark Railroad the earnings were:—

May, 1859	$20,250 35
May, 1858	18,144 59
Increase	$2,105 76

On the Scioto and Hocking Valley Railroad the earnings were May, 1859 ..... $8,689 11

The receipts of the Grand Trunk Railway of Canada for the week ending June 11, were $38,917 27

Week ending June 12, 1858	38,828 27
Increase	$89 00
Total traffic from July 1st.	$2,157,637 78
Same period last year	2,247,036 76
Decrease	$89,398 98

The traffic of the Great Western Railway of Canada for the week ending June 18, 1859, was as follows:

Passengers	$22,636 71
Freight and live stock	9,192 91
Mails and sundries	1,350 61
Total	$33,180 23
Corresponding week of last year	37,584 53
Decrease	$4,404 30

Mobile and Ohio Railroad.

The Columbus Branch of the Mobile and Ohio Railroad is to be completed by the 4th of July, and the people of Columbus—says the Columbus (Miss.) *Democrat*—propose giving a grand celebration of the event.

Commerce of Copper.*

1.—*Imports into the United States.*

Year.	Copper Ores.	Bar or Pig and Old.	In plates (Sheating.)
1849	$177,736	$988,683	$1,044,755
1850	195,332	1,167,411	715,614
1851	65,266	1,531,704	734,610
1852	257,357	1,499,467	610,755
1853	443,796	1,529,295	1,155,414
1854	558,628	1,846,170	851,434
1855	889,007	2,227,457	740,223
1856	695,740	1,388,812	377,655
1857	1,440,314	1,659,513	354,311
1858	1,131,362	1,068,551	111,698

Year.	Manufactures of Copper.	Brass and Manuf. of	Total Value.
1849	$232,038	$175,021	$2,618,233
1850	338,743	179,893	2,596,993
1851	367,196	173,639	2,872,415
1852	135,340	155,992	2,658,911
1853	282,221	236,341	3,647,067
1854	174,391	337,700	3,768,323
1855	165,676	258,770	4,281,133
1856	239,588	224,209	2,926,004
1857	178,130	222,012	3,849,280
1858	109,545	202,484	2,628,640

* Not including coin.

2.—Re-exported from the United States.

Year.	Copper Ores.	Bar or Pig and Old.	In plates (Sheating.)
1849	$625	$63,481	$59,846
1850	6,700	290,068	32,849
1851	....	109,498	23,718
1852	....	3,980	27,848
1853	....	72,929	24,225
1854	....	56,408	56,408
1855	43,009	913,062	30,735
1856	....	86,841	21,802
1857	54,965	394,330	13,795
1858	470,637	508,437	24,863

	Manufactures of Copper.	Brass and Manuf. of	Total Value.
1849	$1,845	$814	$126,611
1850	648	767	331,032
1851	649	4,237	138,102
1852	3,150	276	35,254
1853	44	1,371	98,569
1854	8,717	18,315	83,440
1855	10,547	41,022	1,038,375
1856	7,921	2,808	119,372
1857	17,843	6,216	487,149
1858	99,537	7,984	1,111,458

3.—Retained for Consumption in the United States.

	Copper Ores.	Brass or Pig and Old.	In plates (Sheating.)
1849	$177,111	$925,202	$984,909
1850	188,632	877,343	682,765
1851	65,266	1,422,206	710,892
1852	257,357	1,495,487	582,907
1853	443,796	1,456,366	1,131,189
1854	558,628	1,846,170	795,026
1855	845,998	1,314,395	709,488
1856	995,740	1,301,971	355,853
1857	1,385,349	1,265,183	337,516
1858	660,725	560,114	86,835

Year.	Manufactures of Copper.	Brass and Manuf. of	Total Value.
1849	$230,193	$174,207	$2,491,622
1850	338,095	179,126	2,265,951
1851	366,547	169,402	2,734,313
1852	132,190	155,716	2,623,657
1853	282,177	234,970	3,548,498
1854	165,674	319,385	3,684,883
1855	155,129	217,748	3,242,758
1856	231,667	221,401	2,806,632
1857	155,287	215,796	3,362,031
1858	10,008	194,500	1,512,182

4.—Domestic Copper and Brass, and Manufactures of, Exported.

Year.	Value.
1849	$66,203
1850	105,060
1851	91,871
1852	103,039
1853	108,205
1854	91,984
1855	690,966
1856	534,845
1857	607,054
1858	1,985,223

Interest on Public Debts.

The interest on the Public Debt of the Federal and State Governments, due July 1st, will be paid in this city on and after that date as follows, viz:

Interest on Debt of	Payable at	Amount
United States	Sub-Treasury	$1,000,000
State of Missouri	Bank of Commerce.	600,000
Virginia	B'k of State N. York	320,000
New York	Manhattan Co	350,000
Kentucky	Bank of America	120,000
Tennessee	Merchants' Bank	300,000
Ohio	Ag'cy, 25 William st.	425,000
North Carolina	Bank of Republic	120,000
Georgia	Bank of Republic	30,000
Illinois	Treas. at 95 Wall st.	300,000
Indiana	Agency, 27 Wall st.	170,000
Minnesota	Atlantic Bank	10,000
Michigan	Treas. in New York	75,000
Total interest in New York		$3,820,000

The Public Debt of the United States actually outstanding on 20th June was:

In 5 to 6 per cents., 1862–68	$25,164,000
In new 5 per cents., 1874	18,500,000
In Treasury bills, 1859	13,116,000
Total outstanding June 20	$56,880,000
New 5 per cents. au'rized. $1,500,000	
Re-issue Treas. bills ditto. 6,884,000—	8,384,000
Total issued and authorized	$65,264,000

In addition to the Virginia interest, payable as above in New York, the Commonwealth will pay on about $14,000,000 registered stock in Richmond, and on $1,875,000 in 5 per cent. Sterling bonds in London.

American Railroad Journal.

Saturday, July 2, 1859.

Lease of the Erie Railroad.

Mr. Charles Minot, formerly Superintendent of this road, having associated several gentlemen with him, has submitted to the company a proposition for a lease of this road for a period of 10 years, agreeing to pay $1,500,000 the first year, $1,600,000 the second, $1,700,000 the third, $1,800,000 the fourth, $1,900,000 the fifth, and $2,000,000 the remaining five of the ten years, with privilege of a renewal of the lease for an additional ten years, at $2,500,000 per annum.

The proposed lessees act upon the idea that there is an ample margin for profit in the saving to be effected out of what it would cost the company to carry on the road. This is reasonable. They propose to divide among six or eight competent parties the different departments of services, and by interesting their subordinates in the result, to secure the most efficient co-operation of all employed. In this way they expect to be able to operate the road at a much less rate than it can be done by the company.

We do not see how a great road like the Erie can be successfully conducted in any other manner. There are, in ordinary times, employed upon it, five or six thousand men. Every soul of this great army has his compensation measured by a regular salary, graduated according to the supposed dignity, or responsibility, of his duties. All of a similar grade receive very nearly the same rate of compensation, although some of the parties instead of being valuable officers, may possess no qualifications whatever for their duties, but may be the cause of great loss to the company. The ultimate rule of conduct of each subordinate is the will of the chief executive. With the widest training and experience he can hardly be expected to infuse his own intelligence and energy into those under him, nor exact from them a proper degree of accountability. But if he be entirely inexperienced in their duties, they have no other rule of conduct than their wills. It is easy to see that such a relationship will end in a complete demoralization of the whole operating force.

To remedy such evils a new principle must be introduced into the management of our roads. An inducement must be held out to every person occupying a responsible position, sufficient to make him, at all times, vigilant and faithful, and qualify himself for the discharge of his duties in the best manner possible. The amount of his compensation must be made to depend upon the amount he can save to, or make for, the company. The strongest motive that can be presented to man, is always before him. As a person would be compensated in proportion to his qualifications, the most competent would soon work their way to the most important stations, and the best talent in the country always be found in the management of our roads.

As it is, qualifications have now nothing to do with appointments to office. Presidents and Superintendents are often selected who have never seen an hour of service. These, after trying their hand at their duties, and failing of success, give way to others as incapable as themselves. In this way are our roads constantly shifting their managers, and constantly becoming less and less productive, till one after another is wound up under some one of its mortgages.

Such will be the fate of the Erie unless an entire change of system is inaugurated. We hope, therefore, that the proposition of Mr. Minot will receive careful attention, and that it, or one of a similar character, will receive the assent of the company.

Mississippi Central Railroad.

We give in the present number of the Journal, the late report of this company for the year ending April 30th, 1859, from which it will be seen that this important work is rapidly approaching its completion.

One of the great benefits which this road will confer, will be the formation of a continuous line of railroad to New Orleans. Up to the present time, this great southern metropolis is reached only by water—by the Gulf on one side and the Mississippi river on the other. The delays and dangers of the river navigation are proverbial. The year that has just past has been the witness of terrible disasters. When the road is opened, the route to New Orleans from all important places in the interior will be reduced to one-sixth the time now required. This greater expedition will be obtained with greater safety and at reduced cost for traveling. The annual migration between the North and South, vast as it now is, will receive an additional impulse from the new facilities afforded to it.

This road nearly 200 miles long, will be built and equipped at a cost not exceeding $20,000 per mile. The means have been supplied by people living upon its route. Its cost represents the dollars that have actually been expended in construction, and has not been swelled by fat contracts, or by excessive issues of securities, for the want of adequate means. Other roads, not a whit more expensive, in fact, show a nominal cost exceeding twice that of the Mississippi Central.

The road is now so nearly completed as to be beyond the reach of favorable or unfavorable opinions as to its earnings. We shall be greatly disappointed, however, if these do not excel those of any road in the country of no greater cost. It traverses a very rich planting district, whose market is New Orleans. To the travel of the entire valley of the Mississippi it must sustain the same relation that this river does to its commerce. Millions of dollars are annually paid for the transportation of passengers on that portion of the river parallel to the road. These will be entirely drawn to the road on its completion.

An influence no less valuable will be a political

and moral one. Adequate means of intercourse between the North and the extreme South do not yet exist. This road will go far toward supplying what is wanting. It should bring New Orleans within three and a-half days' travel of New York, —the distance being 1,500 miles. With a few other leading railroads completed, our general system of railroads may be said to be perfect.—The roads to be built will be the *woof* to the great *warp* which will exist.

Post on Wooden Bridges.

We this week conclude the treatise on bridges by Mr. Post. Many inquiries have been made for this work in book form. We understand that it is the intention of the author, at some future time, to pursue the subject; and, if the sections we have published shall appear to meet the approbation of the engineering and architectural professions, the work will be revised, considerably extended and suitably illustrated, and will be published in a shape more useful and convenient for reference.

Interest and Dividends.

The July interest on the County Bonds of the Belmont and Muskingum Counties and the City Bonds of Zanesville, Ohio, issued to the Ohio Central and the Zanesville Roads, will be paid at the Nassau Bank.

Messrs. Morse & Wolff, No. 41 William street, will pay July 1, the coupons of the Dubuque City ten per cent. Bonds.

Messrs. Ashley & Norris, No. 52 Exchange Place, will pay the coupons on the Chicago Sewerage Bonds, due 1st July.

The interest coupons of the Lackawanna and Bloomsburg Railroad Company, due July 1, will be paid on presentation at the Mercantile Bank of this city on and after that date.

The interest of the Bonds of the County of Muscatine, County of Washington, County of Iowa, County of Powesheik and County of Pottawattamie, of the State of Iowa, issued to the Mississippi and Missouri Railroad Company, due July 1, will be paid at the Corn Exchange Bank.

Messrs. Winslow, Lanier & Co. will pay the following coupons, due July 1: State of Indiana 5 per cent. Bank Bond; Indiana Central Railroad 10 per cent. Bonds, 2d Mortgage; Ross County, Ohio, 7 per cent. Bonds; town of Harmar, Ohio, 7 per cent. Bonds; town of Marietta, Ohio, 7 per cent. Bonds.

The Bank of America will pay the interest coupons of the city of New Orleans, and all other bonds of the city, or former municipalities, on which the interest is payable in New York on the 1st of July; also the coupons, No. 6 of the First Mortgage Bonds of the New Orleans, Jackson and Great Northern Railroad Company, payable in New York on the 1st of July.

The interest on Minnesota State Bonds, due 1st July next, will be paid upon presentation of the proper coupons at the Atlantic Bank, New York.

The interest on the bonds of the Mississippi and Missouri Railroad Company, due 1st of July, will be paid by the Corn Exchange Bank.

The semi-annual interest on the bonds of the Joliet and Chicago Railroad of Illinois, due July 1, will be paid on presentation at the office of M. K. Jesup & Co., No. 44 Exchange Place.

The Ocean Bank will pay the coupons of the Jackson County, Ohio, Bonds, due July 1, 1859.

The interest coupons of the Hartford City Bonds, issued to the Hartford, Providence and Fishkill Railroad Company, due on the 1st of July, will be paid at the Phœnix Bank, in the city of Hartford.

The interest coupons of the Bonds of the city of Quincy, Ill., due 1st July, will be paid by Woodruff & Co., 40 Broad street.

The semi-annual interest due July 1, on the Bonds of the Cumberland Coal and Iron Company, will be paid at their office in this city, on and after that date.

The coupons of the Virginia and Tennessee Railroad Company, due July 1, will be paid by Messrs. Peters, Campbell & Co., 50 Wall street, New York.

The coupons on the State of Iowa Bonds; Henderson Co. Bonds, Illinois; Mason Co. Bonds, Illinois; and Rock Island Co. Bonds, Illinois, will be paid, on presentation, at the office of Halstead & Gilman, No. 47 Exchange Place.

The unpaid interest, July 1, on the Bonds of the Yuba County, California, of the issues of 1857 and 1858; and the interest on the Bonds of the County of Athens, Ohio, from No. 1 to 100, inclusive, will be paid on and after that date by Wm. Hoge & Co. No. 50 Wall street.

The coupons on the Bonds of the Long Island Railroad Company, due 1st July, will be paid at the City Bank, Brooklyn.

The coupons of the Jersey City Water Bonds, falling due July 1, 1857, will be paid on presentation at the Continental Bank, N. Y., or at the Mechanics' and Traders' Bank, Jersey City, on the 1st proximo.

The interest on the Third Mortgage Bonds of the Harlem Railroad, due 1st July, will be paid at the office of the Company in 26th street.

The coupons of the Brooklyn City Bonds, due July 1, will be paid at the Long Island Bank.

The Assistant-Treasurer at New York is prepared to pay the half-yearly dividend on the Public Debt of the United States, due July 1st.

The Albany *Journal* gives notice that the surviving Trustees of the old Albany and Schenectady Railroad Company have declared a final dividend of sixty-two cents on each share of the capital stock.

The Western Railroad of Massachusetts has declared a semi-annual dividend of 4 per cent., payable July 5.

The Directors of the Little Miami Railroad, in the early part of last month, declared a semi-annual dividend of four per cent., which was payable on and after the 13th.

The New York, Providence and Boston (Stonington) Railroad, a dividend of two and a half per cent., payable July 1.

We understand that the Cleveland and Columbus Company have the money in hand to pay the usual half-yearly dividend of 5 per cent. in July.

The Nassau Bank, the Bank of Commerce, the People's Bank, the Continental Bank, the New York County Bank, the Hanover Bank, the Bank of North America, the Market Bank, the Commonwealth Bank, the Phœnix Bank, the Atlantic Bank, and the Grocers' Bank, have each declared their half-yearly dividend for July, at the rate of 3½ per cent. The Metropolitan Bank and the Bank of the Metropolis, each 4 per cent.

The Commonwealth Fire Insurance Company has declared a semi-annual dividend of 5 per cent., payable July 1. The half-yearly dividend of the Mercantile Fire Insurance Company is 6 per cent. The Long Island Insurance Company a semi-annual dividend of 10 per cent. The American Fire Insurance Company a dividend of $7 per share. The Harmony Fire and Marine Insurance Company a dividend of 5 per cent. The New Amsterdam Fire Insurance Company a semi-annual dividend of 8 per cent. The People's Fire Insurance Company a semi-annual dividend of 6 per cent., payable June 6. The Hamilton Fire Insurance Company, a dividend of four per cent., payable on the 5th of July.

Southern Pacific Railroad--Mr. J. Edgar Thomson President of it.

We copy the following from the St. Louis *News*:

OFFICE PENNSYLVANIA RAILROAD CO.,
Philadelphia, June 18, 1859.

DEAR SIR—Referring to our conversation at the Saint Nicholas Hotel, New York, I can state that I will accept (on the conditions then named,) the Presidency of the Southern Pacific Railroad Company upon the fulfilment of the following conditions:

First—That the company shall be freed from all its existing debts.

Second—That all questions between the authorities of Texas and the company, involving its legal or corporate rights, shall be satisfactorily settled.

Third—That additional share capital, amounting to at least two hundred and fifty thousand dollars, in addition to the sum required to meet all of the liabilities of the company, shall be obtained in cash.

Yours very truly,
J. EDGAR THOMSON.

J. FOWLKES, M. D., President.

The *News* states that the terms named have been complied with, making Mr. Thomson's conditional acceptance an absolute one. It does not state whether or not Mr. Thomson proposes to go South—such a movement on his part would seem inconsistent with the many duties he owes to several important northern railroads.

Junction Railroad.

The first section of this road from Hamilton to Oxford has been opened for business.

Journal of Railroad Law.

LIABILITY OF RAILROAD CORPORATION FOR DIVERSION OF WATER-COURSE.

The case of Robinson *vs.* The New York and Erie Railroad Company, recently decided in the New York Supreme Court, determines some interesting principles in respect to interference with running streams in the construction of a railway.

The action was commenced in July, 1855, for the recovery of damages to the plaintiff's land and buildings, in the village of Corning, arising from the overflow of a stream, known as the Monkey Run. It was claimed that this overflowing was occasioned by the obstructions placed in the stream by the defendants, at the point where it crosses Erie avenue, in that village.

It appeared on the trial, that the defendants' railroad ran along Erie avenue, and where it crossed the stream in question, an excavation of the banks of the creek was necessary to conform the ground to the grade of the railroad. The defendants deepened the channel of the creek, and constructed two sluices for the passage of the water, ten feet wide each, three feet deep.

In June, 1855, there were three extraordinary floods in the creek. The highest of these floods occurred on the 30th of June, when a great quan-

tity of gravel and earth was washed down the stream, and filled up the sluices under the railroad, and covered the track of the road itself, five or six feet deep. This obstruction turned the water of the creek into Erie avenue, and from thence it ran into, and filled, the cellars of the plaintiff's buildings, and did other damage to his premises. The sluices constructed by the defendants were sufficient to pass all the water of the stream in the highest flood that had ever been known in the creek; the flood of the 30th of June, and which did the damage to the plaintiff's premises, was much the highest flood that had ever been known in the stream. The bank of the creek on the side of the plaintiff's premises, was in its natural state, five or six feet above the bed of the creek. The defendants had cut down this bank in grading its track, and had, at the same time, lowered the bed of the creek, but precisely to what extent did not clearly appear.

The Judge charged the jury, amongst other things, that the general course and flow of streams on the surface of the earth, being governed and controlled by the formation of the surface, no one had any right to make any change or innovation upon the surface, so as to change the established course and flow of any stream, to the prejudice of another. That every person owning and occupying premises in the vicinity of a stream of water, was entitled to have the natural banks and barriers remain unmolested, so far as was necessary for his protection against the overflow and diversion of the stream; and that any person digging down the bank, or removing a natural barrier, by reason of which, such stream overflowing, or was diverted from its natural and established course, to the injury of another, was liable for the injury thus occasioned. That the defendants, although they had by law the right to cross streams in the construction of their road, were liable, if in crossing any stream, they removed the banks to such an extent as to occasion the overflow, or diversion, of the water of such stream by which individuals in the vicinity sustained injury. And if the jury should find, from the evidence, that the injury and damage to the plaintiff, was occasioned by the excavation and removal of the banks of the stream by the defendants, and but for such excavation and removal, the injury and damage complained of, would not have occurred, the defendants were liable in this action.

The defendants' Counsel requested the Judge to charge:

First. That if the jury were satisfied from the evidence, that the defendants in the construction of their road, made provision for the passage of any flood that had ever before been known in this stream, and had exercised such caution and care to provide against damage to others, as prudent men would exercise in like cases, for the protection of their own property, then the defendants were not liable for the damage resulting from this extraordinary flood.

Second. That the defendants, in the construction of their road, were in the exercise of a lawful right, and were not responsible when all reasonable provision and caution was observed to protect others against injury. That if the jury believed from the evidence, that the defendants, in the construction of the road over the water-way in question, exercised as much caution as a prudent man would exercise in the protection of his property, if he owned both the road and property affected, then the defendants ought not to be made liable to the plaintiff.

The Judge refused to charge as thus requested; and to the charge and refusal, the defendants' Counsel excepted. The jury found a verdict in favor of the plaintiff for $3,735; for which sum, with costs, judgment was entered, and the defendants appealed.

The following is the substance of the opinion of the Court on the appeal:

E. Darwin Smith, J.—In the two propositions submitted by the defendants' Counsel, they claimed, in substance, the defendants were in the exercise of a lawful right in constructing their railroad at the place in question, and that, in the exercise of that right, they were not responsible, when all reasonable prudence and caution was observed on their part, to protect others from injury. The charge treats the defendants—a railroad corporation—as the private owners of property, using and improving it for its own benefit; and, like natural persons, responsible for all direct or consequential injuries resulting to others from such use or improvement. The defendants' Counsel claimed, in effect, that the defendants, as such corporation, were only liable for injuries resulting from negligence, or unskilfulness, like municipal corporations, or public officers, acting in the discharge of a public duty. The rule of liability of private corporations is precisely the same as that of individuals. (9 Wheat. 904. 12 *id.* 40. 4 *id.* 688. 4 Hammond 500, 514. 3 Hill 529.)

It is true that the defendants, under the General Railroad Act, were entitled to construct their road across, along, or upon, any stream of water, water-course, street, highway, plank road, turnpike road, or canal, which the route of its road might touch or intersect, restoring the same to its former state, so as not unnecessarily to have impaired its usefulness. (Sess. L. of 1850, ch. 140, § 28.)

But I do not see that this act relieves the defendants' from their liability in this action. The right of the defendants to construct their railroad across this creek is not denied, and is undeniable. But this act of the Legislature, merely gave authority to defendants to cross this creek. It did not, and could not, give any authority to them to invade any private right, without just compensation. The legislative grant authorized the defendants to enter upon, take and appropriate to their own use, on making a just compensation therefor, such lands as they might require for the use of their said railroad, and to cross all intervening waters and streams. But the legislative grant could go no further, so far as it effected private rights. It exempted the defendants from all liabilities, as respects the public, to indictment for a nuisance, or otherwise; but it left all rights of property unaffected. It gave merely a franchise, and could confer no exemption upon the defendants for wrongs to the rights of private property. (21 Conn. Ref. 294, Williams *vs.* The Central Railroad Co. 16 N. Y. Ref. 97, 3 Hill 567.)

Under the charge in this case, the jury have found that the injuries sustained by the plaintiff, would not have occurred but for the excavation and removal of the banks of the stream made by the defendants. Such removal and excavation were made by the defendants for their own use and benefit, and necessarily at their own risk, so far as the rights of others might be affected thereby. No one has the right to change, or interfere with, the flow, course, channel, or banks, of a natural stream, at the risk of others, or to their prejudice. The Legislature authorized the defendants to cross this stream; but it bound them, if they in any way interfered with the flow of water on the banks of the stream, "to restore it to its former state, so as not unnecessarily to have impaired its usefulness." The defendants interfered with the banks and channel of the stream. Did they restore it to its former state, so as not to have impaired its usefulness? They were bound so to restore it, as to leave the rights of other persons in respect to the stream precisely as before they interfered with it—precisely as they stood in the former state of the stream and its banks. In all cases, a railroad corporation under the provisions of the General Railroad Act, or any private charter, where they do not change or affect rights of property, or appropriate the same, and make compensation therefor, must cross, intersect, or run along streams and highways, or other roads, at their peril. If they alter, change, or affect, the stream or the road, they must restore it to its former state, so that the rights of third persons be, in no way, affected injuriously by such change, or they will be responsible in damages for any injury sustained from such omission. And this is practically the rule asserted by the Judge at the Circuit, as the basis of the defendants' liability in this action.

The defendants claim that they are not liable, unless they are guilty of negligence, or unskilfulness, in making the erection, or alteration, involved in crossing a stream or road. The riparian owner upon a stream, or the private owner of the lot situate upon a street or highway, except as against the public authorities, is entitled to have such street, or highway, remain in its former state. He has nothing to do with the question of negligence, or unskilfulness, in respect to a change of its banks, or channel. The question for him, in respect to his rights, is simply and solely, is he damaged by the change, or alteration, made? If so, he is entitled to be compensated to the extent of such damage. A man owning both sides of a private stream, has a right to erect a dam upon his own land, and use the water thereon; but he has no right to flow his neighbor's land, or do him any injury by the erection of such dam. Such neighbor has nothing to do with the question, whether the dam is, or is not, negligently or unskilfully constructed. He is not bound to submit to injury from a dam skilfully constructed, and in respect to which, no allegation of negligence could be maintained. The question for him is simply, is he injured or not by the construction of such dam? (5 Cowen 165.)

There is, it is true, a large class of cases where the rule of liability would be that claimed by the defendants in this case, where no action can be sustained for injuries received not resulting from negligence, or unskilfulness, or some omission of duty. These cases rest upon the rule—*sic utere tuum ut alienum non lædas*, and embrace a large class of injuries to the relative rights of the citizens, redress for which, can be based upon no other rule than this broad principle of equity, and nat-

ural justice. But the plaintiff's right of action does not rest upon this principle. It is based upon the fundamental right of property, the right in and to the soil, and to the things on, and pertaining to, the earth's surface. The cardinal maxim, *aquæ curret et debet currere*, &c., implies that no one has the right to change, or divert, the course, direction, or flow, of a natural stream to the injury of another. All men have a right to base their claims to property, so far as such claims relate to the earth's surface, upon nature's law, upon the assumption that the earth's surface is to remain substantially unchanged. Every change, or alteration, of such surface, where such alteration involves an injury to others, is, therefore, a violation of natural right, and it is upon this violation that the plaintiff is entitled to maintain this action, independently of the questions of negligence, or unskilfulness, of the defendants. This action might have been sustainable, perhaps, on the ground of the insufficiency of the water-way provided by the defendants, or, for their neglect to keep it open, and clear, for the flow of the water. But the plaintiff is not driven to these grounds. The excavation, and removal, of the banks of the stream, left the water to flow out of the natural channel of the creek, and to overflow the plaintiff's premises; and this overflow, the jury have found, would not have happened but for such alteration, and excavation, of the natural banks of the stream.

For the damages resulting from such alteration, and excavation, I think this action clearly maintainable.

NOTICE to RAILROAD CONTRACTORS

OFFICE OF THE RICHMOND & YORK RIVER R. R.,
Richmond, June 25, 1859.

THE undersigned is authorized to receive Proposals for the unfinished Grading, Bridging, Delivery of Cross Ties, Laying the Track, Depots, and all other work necessary to complete the 2nd Division of the Richmond and York River Railroad to West Point (15.3 miles,) including Pamunkey River Bridge, Wharfing at Pamunkey River and at West Point.

Proposals *sealed*, will be received at this office in Rockett's in this city, until the 20th day of July next, at 12 M., where Plans, Specifications and all information necessary for bidders, will be furnished on and after the 10th of July.

Two separate bids to be made by each bidders:—One to state the price in cash for each item; the other to state the price in 8 per cent. 1st Mortgage Bonds of Company at their par value, and 20 per cent. reserved from monthly estimates until contracts are completed.

3t27 D. S. WALTON, Chief Eng'r.

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